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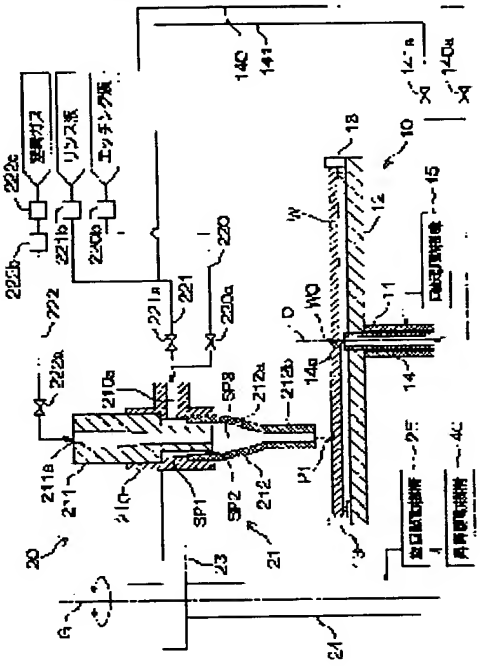
(54) SUBSTRATE PROCESSING DEVICE AND SUBSTRATE PROCESSING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a substrate processing device and a substrate processing method which can inject liquid drips having a desired temperature on the substrate surface and can improve the substrate processing efficiency thereby.
SOLUTION: The substrate processing device treats a surface of a wafer W by injecting the liquid drips formed by mixing gas and liquid on the surface of the wafer W. The device is provided with a soft spray nozzle 21 that forms the liquid drips by mixing the gas and the liquid and injects the liquid drips on the surface of the substrate, an etching liquid supplying pipe 220 and a rinsing liquid supplying pipe 221 to supply the etching liquid and the rinsing liquid each to the soft spray nozzle 21, and a nitrogen gas supplying pipe 222 to supply the nitrogen gas to the soft spray nozzle 21. Each of the etching liquid supplying pipe 220, the rinsing liquid supplying pipe 221, and the nitrogen gas supplying pipe 222 is provided with temperature controllers 220b, 221b and 222b, respectively.



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CLAIMS

[Claim(s)]
[Claim 1] The nozzle which is the substrate processor with which a gas and a liquid inject the drop mixed and generated on the surface of a substrate, and process a substrate front face, is made to mix a gas and a liquid, is made to generate a drop, and injects this drop on the surface of a substrate, The substrate processor characterized by including the liquid supply pipe which is connected to this nozzle and supplies a liquid to this nozzle, the gas supply pipe which is connected to the above-mentioned nozzle and supplies a gas to this nozzle, and a gas temperature control means to adjust the temperature of the gas which circulates this gas supply pipe.
[Claim 2] The substrate processor according to claim 1 characterized by including further a liquid temperature control means to adjust the temperature of the liquid which circulates the above-mentioned liquid supply pipe.
[Claim 3] The above-mentioned gas temperature control means and the above-mentioned liquid temperature control means are a substrate processor according to claim 2 characterized by being what adjusts the gas and liquid of each other which circulate the above-mentioned gas supply pipe and a liquid supply pipe, respectively to equal temperature.
[Claim 4] The above-mentioned nozzle is a substrate processor according to claim 1 to 4 characterized by being the internal hybrid model two fluid nozzle which has the mixing chamber which mixes the liquid from the above-mentioned liquid supply pipe, and the gas from the above-mentioned gas supply pipe inside.
[Claim 5] The process which supplies a liquid to the liquid supply pipe which is the substrate art to which a gas and a liquid inject the drop mixed and generated on the surface of a substrate, and process a substrate front face, and was connected to the nozzle, The process which supplies a gas to the gas supply pipe connected to the above-mentioned nozzle, and the process which adjusts the temperature of the gas which circulates the above-mentioned gas supply pipe, The substrate art characterized by including the process which injects the drop by which the liquid supplied from the above-mentioned liquid supply pipe and the gas supplied from the above-mentioned gas supply pipe were mixed and generated towards the front face of a substrate from the above-mentioned nozzle.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the substrate processor which injects the drop with which the gas and the liquid were mixed on the surface of a substrate, and processes a substrate, and a substrate art. Various kinds of substrates, such as a semi-conductor wafer, the glass substrate for liquid crystal displays, a glass substrate for plasma displays, a substrate for optical disks, a substrate for magnetic disks, a substrate for magneto-optic disks, and a substrate for photo masks, are contained in the substrate of a processing object.
[0002]
[Description of the Prior Art] In the production process of a semiconductor device, in order to wash a semi-conductor wafer (only henceforth a "wafer"), a substrate washing station is used. As a substrate washing station of this application, the thing of a configuration of carrying out the scrub of the wafer front face with a scrub brush has been used from the former, supplying drug solutions (etching reagent etc.) or pure water on the surface of a wafer. However, recently, in order to wash to a precision the wafer front face in which the pole detailed pattern was formed, it replaces with a scrub brush and the so-called thing of the software scrubber method which injects a drop towards a wafer front face from a spray nozzle is adopted increasingly.
[0003] A spray nozzle is also called a two fluid nozzle and association of a liquid supply pipe and a gas supply pipe of it is attained at the nozzle body. By supplying a liquid and a gas to a nozzle body by the predetermined flow rate from a liquid supply pipe and a gas supply pipe, the jet of a drop is formed of mixing with a gas and a liquid, and the jet of this drop is injected towards a wafer front face. In order to heighten the particle removal effectiveness from a wafer front face, generally temperature control of a drug solution is performed. This temperature control is attained by adjusting the temperature of the drug solution which circulates a liquid supply pipe.
[0004]
[Problem(s) to be Solved by the Invention] However, since heat is taken by mixing with a gas when adjusting the temperature of a drug solution more highly than a room temperature, the temperature fall of a drug solution is not escaped but the temperature of the drop of the drug solution which arrives at a wafer front face becomes lower than the adjusted temperature. Therefore, the particle removal effectiveness as expected is not necessarily acquired, but there is a possibility that washing may become poor. Then, the purpose of this invention is offering the substrate processor and substrate art which can solve an above-mentioned technical technical problem, can inject the drop of desired temperature on a substrate front face, and can raise substrate processing effectiveness by this.
[0005]
[The means for solving a technical problem and an effect of the invention] Invention according to claim 1 for attaining the above-mentioned purpose The nozzle which is the substrate processor with which a gas and a liquid inject the drop mixed and generated on the surface of a substrate (W), and process a substrate front face, is made to mix a gas and a liquid, is made to generate a drop, and injects this drop on the surface of a substrate (21), The liquid supply pipe which is connected to this nozzle and supplies a liquid to this nozzle (220,221), It is the substrate

processor characterized by including the gas supply pipe (222) which is connected to the above-mentioned nozzle and supplies a gas to this nozzle, and a gas temperature control means (222b) to adjust the temperature of the gas which circulates this gas supply pipe. In addition, the alphabetic character in a parenthesis expresses the correspondence component in the below-mentioned operation gestalt etc. In the following and this term, it is the same.

[0006] According to this configuration, the gas by which temperature control was carried out with the gas temperature control means is led to a nozzle, and a drop is generated by mixing with this gas and the liquid from a liquid supply pipe, and it is injected on a substrate front face. Therefore, it can prevent that originate in mixing with a liquid and a gas and heat exchange [**** / un-] arises between a liquid and a gas. Consequently, since the drop of suitable temperature can be led to a substrate front face, substrate processing effectiveness can be raised. For example, since the temperature of a drop can be adjusted still more correctly by establishing further a liquid temperature control means (220b, 221b) to adjust the temperature of the liquid which circulates a liquid supply pipe like according to claim 2, the processing effectiveness of a substrate can be improved further.

[0007] If the temperature of the liquid from a liquid supply pipe and the gas from a gas supply pipe has a difference, since the heat exchange between a liquid and a gas arises, temperature control of a drop can also be performed using this. In this case, a liquid temperature control means is not necessarily required. When establishing both a gas temperature control means and a liquid temperature control means, it is desirable that it is what adjusts the gas according to claim 3 into which a gas temperature control means and a liquid temperature control means circulate the above-mentioned gas supply pipe and a liquid supply pipe like, respectively, and the liquid of each other to equal temperature. Since the drop by which temperature control was carried out strictly can be led to a substrate front face by this, efficient substrate processing is possible.

[0008] The above-mentioned nozzle may be an internal hybrid model two fluid nozzle which has the mixing chamber according to claim 4 which mixes the liquid from the above-mentioned liquid supply pipe, and the gas from the above-mentioned gas supply pipe inside like. Moreover, the above-mentioned nozzle may be an external hybrid model two fluid nozzle which is made to mix a gas and a liquid in the air of the exterior of a nozzle, and generates a drop. However, in an external hybrid model two fluid nozzle, in performing mixing with a gas and a liquid in the exterior of a nozzle and performing mixing of a gas and a liquid inside a nozzle by the internal hybrid model two fluid nozzle to a drop diffusing in the shape of an umbrella, since the good drop jet of rectilinear-propagation nature can be formed, an internal hybrid model two fluid nozzle cannot produce the temperature change of a drop easily. Therefore, substrate processing effectiveness with better using an internal hybrid model two fluid nozzle can be attained.

[0009] A gas temperature control means and a liquid temperature control means may adjust the temperature of a gas and a liquid in the range of 40 degrees C - 70 degrees C, respectively. Moreover, a liquid temperature control means may be the thing of a configuration of constituting for example, some gas supply pipes from a metallic conduit (71), approaching this metallic conduit, arranging an electrical heater (72) and a temperature sensor (73), and carrying out energization control of the electrical heater based on the detection temperature of a temperature sensor.

[0010] On the other hand, it may be the configuration of performing energization control of a heat lamp based on the output of a temperature sensor while a liquid temperature control means approaches this quartz tube while constituting for example, some liquid supply pipes [at least] from a quartz tube (50), and it arranges a heat lamp (61 62) and a temperature sensor (65). Generally, without a liquid temperature control means establishing a liquid temperature control means, since the configuration is more complicated than a gas temperature control means, only temperature control of the gas by the gas temperature control means is performed, and if the configuration chiefly performed by the heat exchange between both at the time of mixing with a gas and a liquid is used for the temperature control of a liquid, the whole configuration will be simplified remarkably.

[0011] Invention according to claim 5 is a substrate art to which a gas and a liquid inject the

drop mixed and generated on the surface of a substrate (W), and process a substrate front face. The process which supplies a liquid to the liquid supply pipe (220,221) connected to the nozzle (21), The process which supplies a gas to the gas supply pipe (222) connected to the above-mentioned nozzle, It is the substrate art characterized by including the process which injects the drop which the process which adjusts the temperature of the gas which circulates the above-mentioned gas supply pipe, the liquid supplied from the above-mentioned liquid supply pipe towards the front face of the above-mentioned nozzle to a substrate, and the gas supplied from the above-mentioned gas supply pipe were mixed, and was generated.

[0012] By this approach, the effectiveness described in relation to invention of claim 1 and the same effectiveness can be attained.

[0013]

[Embodiment of the Invention] Below, the gestalt of implementation of this invention is explained to a detail with reference to an accompanying drawing. Drawing 1 is a conceptual diagram for explaining the configuration of the substrate processor concerning 1 operation gestalt of this invention. This substrate processor is a substrate washing station for the so-called software scrubber processing to wash the front face of the wafer W which is a kind of a substrate. This substrate processor is equipped with the spin chuck 10 which holds Wafer W almost horizontally and rotates, the scanning nozzle device 20 in which the software spray nozzle 21 is made to rock along the top face of the wafer W held at the spin chuck 10, and the rear-face nozzle 14 for supplying processing liquid towards the center of the rear face (inferior surface of tongue) of the wafer W held at the spin chuck 10.

[0014] The pinching pawl 13 is set up at the method edge of the outside of the radius-of-gyration direction of this spin base 12, and a spin chuck 10 is constituted while it attaches the spin base 12 in the upper limit of the revolving shaft 11 of the hollow arranged along the direction of a vertical almost horizontally. Two or more pinching pawls 13 are formed on the spin base 12, and hold the location where the hoop directions of Wafer W differ by two or more places. Rotation driving force is given to a revolving shaft 11 from the rotation drive 15. The wafer W which was pinched by the pinching pawl 13 and held almost horizontally by this will rotate to the circumference of the axis of rotation O which meets in the direction of a vertical.

[0015] The rear-face nozzle 14 consists of a processing liquid supply pipe formed so that a revolving shaft 11 might be inserted in, and it has delivery 14a which carried out opening to the upper limit near the inferior-surface-of-tongue center of Wafer W. The etching reagent (drug solution) from an etching-reagent source of supply is given through the etching-reagent charging line 140 and etching-reagent supply bulb 140a, and also the rinse (pure water) from a rinse source of supply is given to this rear-face nozzle 14 through the rinse charging line 141 and rinse supply bulb 141a.

[0016] By opening alternatively etching-reagent supply bulb 140a or rinse supply bulb 141a, an etching reagent or pure water can be supplied in the center of a rear face of Wafer W from the rear-face nozzle 14. When a spin chuck 10 rotates in this condition, the processing liquid (an etching reagent or rinse) supplied to the rear face of Wafer W will be led to the method side of the outside of the radius-of-gyration direction according to a centrifugal force, and processing liquid will spread throughout the rear face of Wafer W.

[0017] The scanning nozzle device 20 is equipped with the fixed pivot 24 established along the direction of a vertical in the side of a spin chuck 10, the swinging arm 23 fixed almost horizontally near the upper limit of this fixed pivot 24, and the software spray nozzle 21 fixed to the point of this swinging arm 23. The revolution drive 25 which carries out the rotation drive of this fixed pivot 24 at the circumference of the axis of rotation G which meets in the direction of a vertical is combined with the fixed pivot 24. Furthermore, the revolution drive 25 and a fixed pivot 24 go up and down with the rise-and-fall drive 40.

[0018] The software spray nozzle 21 is the so-called two fluid nozzle of an internal hybrid model, and the gas induction 211, the liquid induction 210, and the drop formation discharge part 212 are connected, and it is constituted. The gas induction 211, the liquid induction 210, and the drop formation discharge part 212 all have the tubing configuration, these are connected with a serial, and the software spray nozzle 21 is constituted. The drop formation discharge part 212 stands in

a row in the lower limit of taper section 212a to which a bore becomes small, and this 212a as it is connected with the lower part edge of the liquid induction 210 and goes caudad, and it has straight section 212b of a straight pipe configuration with a uniform bore.

[0019] The gas induction 211 has the major diameter which engages with the top section of the liquid induction 210, and the narrow diameter portion which this major diameter stands in a row caudad, and arrives at even the building envelope of the drop formation discharge part 212, it tapers off in that interior, and gas installation way 211a of a configuration is formed. To the liquid induction 210, liquid installation way 210a for introducing a liquid carries out opening, and is formed in the side at it, and this liquid installation way 210a is open for free passage to the space SP 1 of the shape of a ring between the narrow diameter portion of the gas induction 211, and the wall of the liquid induction 210. This space SP 1 is open for free passage through the space SP 2 of the shape of a ring between the narrow diameter portion of the gas induction 211, and the wall of the drop formation discharge part 212 with the building envelope SP 3 (mixing chamber) of taper section 212a of the drop formation discharge part 212.

[0020] The nitrogen charging line 222 which supplies the nitrogen from the source of nitrogen gas supply is connected to gas installation way 211a of the gas induction 211. Filter 220c, temperature-controller 222b, and nitrogen gas supply bulb 222a are infixed in the section sequentially from the source side of nitrogen gas supply in the middle of this nitrogen charging line 222. The rinse charging line 221 and the etching-reagent charging line 220 are connected to liquid installation way 210a. Temperature-controller 220b and etching-reagent supply bulb 220a are infixed in the section sequentially from the etching-reagent source-of-supply side in the middle of the etching-reagent charging line 220. Moreover, temperature-controller 221b and rinse supply bulb 221a are infixed in the section sequentially from the rinse source-of-supply side in the middle of the rinse charging line 221.

[0021] In the software spray nozzle 21, the gas supplied from gas installation way 211a and the gas supplied through space SP1 and SP2 from liquid installation way 210a will be mixed in space SP 3, consequently a drop will be formed. It is accelerated by taper section 212a, and this drop is injected towards Wafer W through straight section 212b. The jet of this drop has very good rectilinear-propagation nature by work of straight section 212b.

[0022] The particle size of a drop is 5 micrometers - 20 micrometers. Moreover, the flow rate of the gas (nitrogen gas) supplied to the software spray nozzle 21 has desirable 50l. 100l. part for /- and thing [a part for /], and the flow rate of the liquid (an etching reagent or rinse) supplied to the software spray nozzle 21 has desirable 100ml 150ml part for /- and thing [a part for /]. 10rpm - 1000rpm is suitable for the rotational speed (rotational speed of a spin chuck 10) of Wafer W.

[0023] Thermoregulators 220b, 221b, and 222b all carry out temperature control of an etching reagent, a rinse, and the nitrogen gas to equal temperature (for example, 40 degrees C - 70 degrees C), respectively. Therefore, when a gas and a liquid are mixed in space SP 3 (mixing chamber), the temperature exchange between a gas and a liquid does not arise. Therefore, the drop of the etching reagent by which temperature control was carried out good, or a rinse can be led to the front face of Wafer W. Thereby, efficient processing of Wafer W is attained.

[0024] At the time of processing of the wafer W by the software spray nozzle 21, a spin chuck 10 rotates by work of the rotation drive 15, etching-reagent supply bulb 220a or rinse supply bulb 221a is opened, and nitrogen gas supply bulb 222a is opened further. While the lower limit of straight section 212b is arranged by work of the rise-and-fall drive 40 near the wafer W with it, a swinging arm 23 is made to rock by work of the revolution drive 25. By this, the processing location P1 of the wafer W front face to which the jet of the drop from the software spray nozzle 21 is led will be repeatedly moved from the center of rotation WO of Wafer W to the method edge of the outside of a radius of gyration.

[0025] At this time, Kaisei of etching-reagent supply bulb 140a or the rinse supply bulb 141a is carried out if needed, and an etching reagent or a rinse is supplied in the center of a rear face of Wafer W from the rear-face nozzle 14. Drawing 2 is an illustration-perspective view for explaining the example of a configuration of thermoregulator 220b for performing temperature control of an etching reagent. This temperature-controller 220b is equipped with the drug solution tank 50 and

the lamp heaters 61 and 62 made from the quartz with which the drug solution (etching reagent) which circulates the etching-reagent charging line 220 circulates. The drug solution tank 50 has the shape of a direct cylindrical shape mostly, on the other hand, has the drug solution inflow port 51 in an end face, and has the drug solution outflow port 52 in the another side end face. Furthermore, the cylindrical shape insertion holes 53 and 54 which insert both-ends face-to-face in the drug solution tank 50 are formed along the direction of an axis. The straight pipe-like lamp heaters 61 and 62 are inserted in these cylindrical shape insertion holes 53 and 54, respectively. The temperature sensor 65 is arranged at the peripheral surface of the drug solution tank 50, and a controller 70 controls the energization to the lamp heaters 61 and 62 based on the output of this temperature sensor 65.

[0026] By infixing this temperature-controller 220b in the etching-reagent charging line 220, the temperature of the etching reagent which circulates the etching-reagent charging line 220 can be adjusted. Temperature-controller 221b infixed in the rinse charging line 221 is also temperature-controller 220b for etching reagents with the same configuration substantially. Drawing 3 is the illustration-perspective view showing the example of a configuration of thermoregulator 222b infixed in the nitrogen gas supply piping 222. This temperature-controller 222b is equipped with the heating-wire heater 72 arranged spirally on the metal piping 71 arranged at zigzag, and this metal piping 71. the metal piping 71 is contacted, the temperature sensor (or the heat transfer member which the heat from the metal piping 71 is delivered — contacting) 73 is formed, and a controller 75 controls the energization to the heating-wire heater 72 based on the output of this temperature sensor 73. By this configuration, the metal piping 71 can be adjusted to the temperature of a request of the circulating gas.

[0027] As mentioned above, while temperature control of the etching reagent supplied to the software spray nozzle 21 and a rinse is performed according to this operation gestalt, the temperature of the nitrogen gas mixed with these liquids is also adjusted. And the nitrogen gas, rinse, or etching reagent adjusted by equal temperature is mixed by the software spray nozzle 21, and the drop of an etching reagent or a rinse is injected towards the front face of Wafer W. Since heat exchange does not arise between the nitrogen gas of equal temperature, a rinse, or an etching reagent, the drop of the etching reagent of desired temperature or a rinse can be certainly led to the front face of Wafer W, and, thereby, the front face of Wafer W can be processed efficiently.

[0028] Although explanation of 1 operation gestalt of this invention is as above, this invention can also carry it out with other gestalten. For example, although the above-mentioned operation gestalt explained the substrate processor which used the two fluid nozzle of an internal hybrid model as a software spray nozzle 21, the two fluid nozzle of an external hybrid model may be used as a software spray nozzle 21. In the gas induction 82 of a major diameter, it fits into the same axle and the external hybrid model two fluid nozzle consists of liquid induction 81 and this liquid induction 81, as shown in drawing 4 .

[0029] The liquid induction 81 has penetrated the gas induction 82 mostly, and liquid supply way 81a formed in the interior is opening it for free passage to the outer space near the nozzle tip. On the other hand, the gas induction 82 has gas inlet 82a on the side face, and this gas inlet 82a is opening it for free passage in the interior of the gas induction 82 to the space 83 formed between that wall and outer wall of the liquid induction 81. the collar with which the point of the liquid induction 81 spread in the method of outside — it forms in a configuration — having — **** — this collar — the gas path 84 which makes between the above-mentioned space 83 and the outer space near the tip of the software spray nozzle concerned open for free passage is formed in the configuration section.

[0030] While supplying a liquid to liquid supply way 81a, when a gas is supplied from gas inlet 82a, in the outer space 85 near a nozzle tip, a liquid and a gas will be mixed by this configuration in the air, and a drop will be formed of it. This drop is injected along the direction of the blowdown of a liquid and a gas, i.e., the shaft orientations of the liquid induction 81. However, in this external hybrid model two fluid nozzle, the jet of a drop spreads with the not not much sufficient rectilinear-propagation nature of a drop in the shape of an umbrella as compared with an internal hybrid model two fluid nozzle.

[0031] Since the rectilinear-propagation nature of a drop jet is good while mixing with a gas and a liquid is performed inside a nozzle in an internal hybrid model two fluid nozzle when an internal hybrid model two fluid nozzle is compared with an external hybrid model two fluid nozzle, it is advantageous at the point which it is hard to produce the temperature change of a drop, and can supply the drop of desired temperature to the front face of Wafer W certainly. Therefore, substrate processing that effectiveness is more high is possible by using an internal hybrid model two fluid nozzle as a software spray nozzle 21.
[0032] Moreover, while adjusting the temperature of nitrogen gas by temperature-controller 222b, although [the above-mentioned operation gestalt] the temperature of an etching reagent and a rinse is adjusted with temperature controllers 220b and 221b, the temperature controllers 220b and 221b for an etching reagent and a rinse can be excluded, and a configuration can also be simplified further. In this case, it is desirable to set up by thermoregulator 222b more highly than the drop temperature of a request of the temperature of nitrogen gas. Thereby, by mixing of the nitrogen gas in the software spray nozzle 21 and an etching reagent, or a rinse, heat exchange arises between nitrogen gas, an etching reagent, or a rinse, and the drop of desired temperature can be turned to the front face of Wafer W, and can be injected. the configuration of temperature-controller 222b for nitrogen gas is markedly boiled as compared with the configuration of the temperature controllers 220b and 221b for an etching reagent or a rinse, and it can be contributed to the cost cut of a substrate processor while a configuration becomes remarkably easy, since it is simple.
[0033] In addition, it is possible to perform design changes various in the range of the matter indicated by the claim.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the substrate processor which injects the drop with which the gas and the liquid were mixed on the surface of a substrate, and processes a substrate, and a substrate art. Various kinds of substrates, such as a semi-conductor wafer, the glass substrate for liquid crystal displays, a glass substrate for plasma displays, a substrate for optical disks, a substrate for magnetic disks, a substrate for magneto-optic disks, and a substrate for photo masks, are contained in the substrate of a processing object.

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PRIOR ART

[Description of the Prior Art] In the production process of a semiconductor device, in order to wash a semi-conductor wafer (only henceforth a "wafer"), a substrate washing station is used. As a substrate washing station of this application, the thing of a configuration of carrying out the scrub of the wafer front face with a scrub brush has been used from the former, supplying drug solutions (etching reagent etc.) or pure water on the surface of a wafer. However, recently, in order to wash to a precision the wafer front face in which the pole detailed pattern was formed, it replaces with a scrub brush and the so-called thing of the software scrubber method which injects a drop towards a wafer front face from a spray nozzle is adopted increasingly.
[0003] A spray nozzle is also called a two fluid nozzle and association of a liquid supply pipe and a gas supply pipe of it is attained at the nozzle body. By supplying a liquid and a gas to a nozzle body by the predetermined flow rate from a liquid supply pipe and a gas supply pipe, the jet of a drop is formed of mixing with a gas and a liquid, and the jet of this drop is injected towards a wafer front face. In order to heighten the particle removal effectiveness from a wafer front face, generally temperature control of a drug solution is performed. This temperature control is attained by adjusting the temperature of the drug solution which circulates a liquid supply pipe.

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EFFECT OF THE INVENTION

[The means for solving a technical problem and an effect of the invention] Invention according to claim 1 for attaining the above-mentioned purpose The nozzle which is the substrate processor with which a gas and a liquid inject the drop mixed and generated on the surface of a substrate (W), and process a substrate front face, is made to mix a gas and a liquid, is made to generate a drop, and injects this drop on the surface of a substrate (21), The liquid supply pipe which is connected to this nozzle and supplies a liquid to this nozzle (220,221), It is the substrate processor characterized by including the gas supply pipe (222) which is connected to the above-mentioned nozzle and supplies a gas to this nozzle, and a gas temperature control means (222b) to adjust the temperature of the gas which circulates this gas supply pipe. In addition, the alphabetic character in a parenthesis expresses the correspondence component in the below-mentioned operation gestalt etc. In the following and this term, it is the same.
[0006] According to this configuration, the gas by which temperature control was carried out with the gas temperature control means is led to a nozzle, and a drop is generated by mixing with this gas and the liquid from a liquid supply pipe, and it is injected on a substrate front face. Therefore, it can prevent that originate in mixing with a liquid and a gas and heat exchange [**** / un-] arises between a liquid and a gas. Consequently, since the drop of suitable temperature can be led to a substrate front face, substrate processing effectiveness can be raised. For example, since the temperature of a drop can be adjusted still more correctly by establishing further a liquid temperature control means (220b, 221b) to adjust the temperature of the liquid which circulates a liquid supply pipe like according to claim 2, the processing effectiveness of a substrate can be improved further.
[0007] If the temperature of the liquid from a liquid supply pipe and the gas from a gas supply pipe has a difference, since the heat exchange between a liquid and a gas arises, temperature control of a drop can also be performed using this. In this case, a liquid temperature control means is not necessarily required. When establishing both a gas temperature control means and a liquid temperature control means, it is desirable that it is what adjusts the gas according to claim 3 into which a gas temperature control means and a liquid temperature control means circulate the above-mentioned gas supply pipe and a liquid supply pipe like, respectively, and the liquid of each other to equal temperature. Since the drop by which temperature control was carried out strictly can be led to a substrate front face by this, efficient substrate processing is possible.
[0008] The above-mentioned nozzle may be an internal hybrid model two fluid nozzle which has the mixing chamber according to claim 4 which mixes the liquid from the above-mentioned liquid supply pipe, and the gas from the above-mentioned gas supply pipe inside like. Moreover, the above-mentioned nozzle may be an external hybrid model two fluid nozzle which is made to mix a gas and a liquid in the air of the exterior of a nozzle, and generates a drop. However, in an external hybrid model two fluid nozzle, in performing mixing with a gas and a liquid in the exterior of a nozzle and performing mixing of a gas and a liquid inside a nozzle by the internal hybrid model two fluid nozzle to a drop diffusing in the shape of an umbrella, since the good drop jet of rectilinear-propagation nature can be formed, an internal hybrid model two fluid nozzle cannot produce the temperature change of a drop easily. Therefore, substrate processing effectiveness

with better using an internal hybrid model two fluid nozzle can be attained.
[0009] A gas temperature control means and a liquid temperature control means may adjust the temperature of a gas and a liquid in the range of 40 degrees C - 70 degrees C, respectively. Moreover, a liquid temperature control means may be the thing of a configuration of constituting for example, some gas supply pipes from a metallic conduit (71), approaching this metallic conduit, arranging an electrical heater (72) and a temperature sensor (73), and carrying out energization control of the electrical heater based on the detection temperature of a temperature sensor.
[0010] On the other hand, it may be the configuration of performing energization control of a heat lamp based on the output of a temperature sensor while a liquid temperature control means approaches this quartz tube while constituting for example, some liquid supply pipes [at least] from a quartz tube (50), and it arranges a heat lamp (61 62) and a temperature sensor (65). Generally, without a liquid temperature control means establishing a liquid temperature control means, since the configuration is more complicated than a gas temperature control means, only temperature control of the gas by the gas temperature control means is performed, and if the configuration chiefly performed by the heat exchange between both at the time of mixing with a gas and a liquid is used for the temperature control of a liquid, the whole configuration will be simplified remarkably.
[0011] Invention according to claim 5 is a substrate art to which a gas and a liquid inject the drop mixed and generated on the surface of a substrate (W), and process a substrate front face. The process which supplies a liquid to the liquid supply pipe (220,221) connected to the nozzle (21), The process which supplies a gas to the gas supply pipe (222) connected to the above-mentioned nozzle, It is the substrate art characterized by including the process which injects the drop which the process which adjusts the temperature of the gas which circulates the above-mentioned gas supply pipe, the liquid supplied from the above-mentioned liquid supply pipe towards the front face of the above-mentioned nozzle to a substrate, and the gas supplied from the above-mentioned gas supply pipe were mixed, and was generated.
[0012] By this approach, the effectiveness described in relation to invention of claim 1 and the same effectiveness can be attained.
[0013]
[Embodiment of the Invention] Below, the gestalt of implementation of this invention is explained to a detail with reference to an accompanying drawing. Drawing 1 is a conceptual diagram for explaining the configuration of the substrate processor concerning 1 operation gestalt of this invention. This substrate processor is a substrate washing station for the so-called software scrubber processing to wash the front face of the wafer W which is a kind of a substrate. This substrate processor is equipped with the spin chuck 10 which holds Wafer W almost horizontally and rotates, the scanning nozzle device 20 in which the software spray nozzle 21 is made to rock along the top face of the wafer W held at the spin chuck 10, and the rear-face nozzle 14 for supplying processing liquid towards the center of the rear face (inferior surface of tongue) of the wafer W held at the spin chuck 10.
[0014] The pinching pawl 13 is set up at the method edge of the outside of the radius-of-gyration direction of this spin base 12, and a spin chuck 10 is constituted while it attaches the spin base 12 in the upper limit of the revolving shaft 11 of the hollow arranged along the direction of a vertical almost horizontally. Two or more pinching pawls 13 are formed on the spin base 12, and hold the location where the hoop directions of Wafer W differ by two or more places. Rotation driving force is given to a revolving shaft 11 from the rotation drive 15. The wafer W which was pinched by the pinching pawl 13 and held almost horizontally by this will rotate to the circumference of the axis of rotation O which meets in the direction of a vertical.
[0015] The rear-face nozzle 14 consists of a processing liquid supply pipe formed so that a revolving shaft 11 might be inserted in, and it has delivery 14a which carried out opening to the upper limit near the inferior-surface-of-tongue center of Wafer W. The etching reagent (drug solution) from an etching-reagent source of supply is given through the etching-reagent charging line 140 and etching-reagent supply bulb 140a, and also the rinse (pure water) from a rinse source of supply is given to this rear-face nozzle 14 through the rinse charging line 141 and

rinse supply bulb 141a.
[0016] By opening alternatively etching-reagent supply bulb 140a or rinse supply bulb 141a, an etching reagent or pure water can be supplied in the center of a rear face of Wafer W from the rear-face nozzle 14. When a spin chuck 10 rotates in this condition, the processing liquid (an etching reagent or rinse) supplied to the rear face of Wafer W will be led to the method side of the outside of the radius-of-gyration direction according to a centrifugal force, and processing liquid will spread throughout the rear face of Wafer W.
[0017] The scanning nozzle device 20 is equipped with the fixed pivot 24 established along the direction of a vertical in the side of a spin chuck 10, the swinging arm 23 fixed almost horizontally near the upper limit of this fixed pivot 24, and the software spray nozzle 21 fixed to the point of this swinging arm 23. The revolution drive 25 which carries out the rotation drive of this fixed pivot 24 at the circumference of the axis of rotation G which meets in the direction of a vertical is combined with the fixed pivot 24. Furthermore, the revolution drive 25 and a fixed pivot 24 go up and down with the rise-and-fall drive 40.
[0018] The software spray nozzle 21 is the so-called two fluid nozzle of an internal hybrid model, and the gas induction 211, the liquid induction 210, and the drop formation discharge part 212 are connected, and it is constituted. The gas induction 211, the liquid induction 210, and the drop formation discharge part 212 all have the tubing configuration, these are connected with a serial, and the software spray nozzle 21 is constituted. The drop formation discharge part 212 stands in a row in the lower limit of taper section 212a to which a bore becomes small, and this 212a as it is connected with the lower part edge of the liquid induction 210 and goes caudad, and it has straight section 212b of a straight pipe configuration with a uniform bore.
[0019] The gas induction 211 has the major diameter which engages with the top section of the liquid induction 210, and the narrow diameter portion which this major diameter stands in a row caudad, and arrives at even the building envelope of the drop formation discharge part 212, it tapers off in that interior, and gas installation way 211a of a configuration is formed. To the liquid induction 210, liquid installation way 210a for introducing a liquid carries out opening, and is formed in the side at it, and this liquid installation way 210a is open for free passage to the space SP 1 of the shape of a ring between the narrow diameter portion of the gas induction 211, and the wall of the liquid induction 210. This space SP 1 is open for free passage through the space SP 2 of the shape of a ring between the narrow diameter portion of the gas induction 211, and the wall of the drop formation discharge part 212 with the building envelope SP 3 (mixing chamber) of taper section 212a of the drop formation discharge part 212.
[0020] The nitrogen charging line 222 which supplies the nitrogen from the source of nitrogen gas supply is connected to gas installation way 211a of the gas induction 211. Filter 220c, temperature-controller 222b, and nitrogen gas supply bulb 222a are infixed in the section sequentially from the source side of nitrogen gas supply in the middle of this nitrogen charging line 222. The rinse charging line 221 and the etching-reagent charging line 220 are connected to liquid installation way 210a. Temperature-controller 220b and etching-reagent supply bulb 220a are infixed in the section sequentially from the etching-reagent source-of-supply side in the middle of the etching-reagent charging line 220. Moreover, temperature-controller 221b and rinse supply bulb 221a are infixed in the section sequentially from the rinse source-of-supply side in the middle of the rinse charging line 221.
[0021] In the software spray nozzle 21, the gas supplied from gas installation way 211a and the gas supplied through space SP1 and SP2 from liquid installation way 210a will be mixed in space SP 3, consequently a drop will be formed. It is accelerated by taper section 212a, and this drop is injected towards Wafer W through straight section 212b. The jet of this drop has very good rectilinear-propagation nature by work of straight section 212b.
[0022] The particle size of a drop is 5 micrometers - 20 micrometers. Moreover, the flow rate of the gas (nitrogen gas) supplied to the software spray nozzle 21 has desirable 50l. 100l. part for /- and thing [a part for /], and the flow rate of the liquid (an etching reagent or rinse) supplied to the software spray nozzle 21 has desirable 100ml 150ml part for /- and thing [a part for /]. 10rpm - 1000rpm is suitable for the rotational speed (rotational speed of a spin chuck 10) of Wafer W.

[0023] Thermoregulators 220b, 221b, and 222b all carry out temperature control of an etching reagent, a rinse, and the nitrogen gas to equal temperature (for example, 40 degrees C - 70 degrees C), respectively. Therefore, when a gas and a liquid are mixed in space SP 3 (mixing chamber), the temperature exchange between a gas and a liquid does not arise. Therefore, the drop of the etching reagent by which temperature control was carried out good, or a rinse can be led to the front face of Wafer W. Thereby, efficient processing of Wafer W is attained.
[0024] At the time of processing of the wafer W by the software spray nozzle 21, a spin chuck 10 rotates by work of the rotation drive 15, etching-reagent supply bulb 220a or rinse supply bulb 221a is opened, and nitrogen gas supply bulb 222a is opened further. While the lower limit of straight section 212b is arranged by work of the rise-and-fall drive 40 near the wafer W with it, a swinging arm 23 is made to rock by work of the revolution drive 25. By this, the processing location P1 of the wafer W front face to which the jet of the drop from the software spray nozzle 21 is led will be repeatedly moved from the center of rotation WO of Wafer W to the method edge of the outside of a radius of gyration.
[0025] At this time, Kaisei of etching-reagent supply bulb 140a or the rinse supply bulb 141a is carried out if needed, and an etching reagent or a rinse is supplied in the center of a rear face of Wafer W from the rear-face nozzle 14. Drawing 2 is an illustration-perspective view for explaining the example of a configuration of thermoregulator 220b for performing temperature control of an etching reagent. This temperature-controller 220b is equipped with the drug solution tank 50 and the lamp heaters 61 and 62 made from the quartz with which the drug solution (etching reagent) which circulates the etching-reagent charging line 220 circulates. The drug solution tank 50 has the shape of a direct cylindrical shape mostly, on the other hand, has the drug solution inflow port 51 in an end face, and has the drug solution outflow port 52 in the another side end face. Furthermore, the cylindrical shape insertion holes 53 and 54 which insert both-ends face-to-face in the drug solution tank 50 are formed along the direction of an axis. The straight pipe-like lamp heaters 61 and 62 are inserted in these cylindrical shape insertion holes 53 and 54, respectively. The temperature sensor 65 is arranged at the peripheral surface of the drug solution tank 50, and a controller 70 controls the energization to the lamp heaters 61 and 62 based on the output of this temperature sensor 65.
[0026] By infixing this temperature-controller 220b in the etching-reagent charging line 220, the temperature of the etching reagent which circulates the etching-reagent charging line 220 can be adjusted. Temperature-controller 221b infixed in the rinse charging line 221 is also temperature-controller 220b for etching reagents with the same configuration substantially. Drawing 3 is the illustration-perspective view showing the example of a configuration of thermoregulator 222b infixed in the nitrogen gas supply piping 222. This temperature-controller 222b is equipped with the heating-wire heater 72 arranged spirally on the metal piping 71 arranged at zigzag, and this metal piping 71. the metal piping 71 is contacted, the temperature sensor (or the heat transfer member which the heat from the metal piping 71 is delivered -- contacting) 73 is formed, and a controller 75 controls the energization to the heating-wire heater 72 based on the output of this temperature sensor 73. By this configuration, the metal piping 71 can be adjusted to the temperature of a request of the circulating gas.
[0027] As mentioned above, while temperature control of the etching reagent supplied to the software spray nozzle 21 and a rinse is performed according to this operation gestalt, the temperature of the nitrogen gas mixed with these liquids is also adjusted. And the nitrogen gas, rinse, or etching reagent adjusted by equal temperature is mixed by the software spray nozzle 21, and the drop of an etching reagent or a rinse is injected towards the front face of Wafer W. Since heat exchange does not arise between the nitrogen gas of equal temperature, a rinse, or an etching reagent, the drop of the etching reagent of desired temperature or a rinse can be certainly led to the front face of Wafer W, and, thereby, the front face of Wafer W can be processed efficiently.
[0028] Although explanation of 1 operation gestalt of this invention is as above, this invention can also carry it out with other gestalten. For example, although the above-mentioned operation gestalt explained the substrate processor which used the two fluid nozzle of an internal hybrid model as a software spray nozzle 21, the two fluid nozzle of an external hybrid model may be

used as a software spray nozzle 21. In the gas induction 82 of a major diameter, it fits into the same axle and the external hybrid model two fluid nozzle consists of liquid induction 81 and this liquid induction 81, as shown in drawing 4 .

[0029] The liquid induction 81 has penetrated the gas induction 82 mostly, and liquid supply way 81a formed in the interior is opening it for free passage to the outer space near the nozzle tip. On the other hand, the gas induction 82 has gas inlet 82a on the side face, and this gas inlet 82a is opening it for free passage in the interior of the gas induction 82 to the space 83 formed between that wall and outer wall of the liquid induction 81. the collar with which the point of the iiquid induction 81 spread in the method of outside — it forms in a configuration — having — **** — this collar — the gas path 84 which makes between the above-mentioned space 83 and the outer space near the tip of the software spray nozzle concerned open for free passage is formed in the configuration section.

[0030] While supplying a liquid to liquid supply way 81a, when a gas is supplied from gas inlet 82a, in the outer space 85 near a nozzle tip, a liquid and a gas will be mixed by this configuration in the air, and a drop will be formed of it. This drop is injected along the direction of the blowdown of a liquid and a gas, i.e., the shaft orientations of the liquid induction 81. However, in this external hybrid model two fluid nozzle, the jet of a drop spreads with the not not much sufficient rectilinear-propagation nature of a drop in the shape of an umbrella as compared with an internal hybrid model two fluid nozzle.

[0031] Since the rectilinear-propagation nature of a drop jet is good while mixing with a gas and a liquid is performed inside a nozzle in an internal hybrid model two fluid nozzle when an internal hybrid model two fluid nozzle is compared with an external hybrid model two fluid nozzle, it is advantageous at the point which it is hard to produce the temperature change of a drop, and can supply the drop of desired temperature to the front face of Wafer W certainly. Therefore, substrate processing that effectiveness is more high is possible by using an internal hybrid model two fluid nozzle as a software spray nozzle 21.

[0032] Moreover, while adjusting the temperature of nitrogen gas by temperature-controller 222b, although [the above-mentioned operation gestalt] the temperature of an etching reagent and a rinse is adjusted with temperature controllers 220b and 221b, the temperature controllers 220b and 221b for an etching reagent and a rinse can be excluded, and a configuration can also be simplified further. In this case, it is desirable to set up by thermoregulator 222b more highly than the drop temperature of a request of the temperature of nitrogen gas. Thereby, by mixing of the nitrogen gas in the software spray nozzle 21 and an etching reagent, or a rinse, heat exchange arises between nitrogen gas, an etching reagent, or a rinse, and the drop of desired temperature can be turned to the front face of Wafer W, and can be injected. the configuration of temperature-controller 222b for nitrogen gas is markedly boiled as compared with the configuration of the temperature controllers 220b and 221b for an etching reagent or a rinse, and it can be contributed to the cost cut of a substrate processor while a configuration becomes remarkably easy, since it is simple.

[0033] In addition, it is possible to perform design changes various in the range of the matter indicated by the claim.

[Translation done.]

* NOTICES *

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since heat is taken by mixing with a gas when adjusting the temperature of a drug solution more highly than a room temperature, the temperature fall of a drug solution is not escaped but the temperature of the drop of the drug solution which arrives at a wafer front face becomes lower than the adjusted temperature. Therefore, the particle removal effectiveness as expected is not necessarily acquired, but there is a possibility that washing may become poor. Then, the purpose of this invention is offering the substrate processor and substrate art which can solve an above-mentioned technical technical problem, can inject the drop of desired temperature on a substrate front face, and can raise substrate processing effectiveness by this.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a conceptual diagram for explaining the configuration of the substrate processor concerning 1 operation gestalt of this invention.
[Drawing 2] It is an illustration-perspective view for explaining the example of a configuration of the thermoregulator for performing temperature control of an etching reagent.
[Drawing 3] It is the illustration-perspective view showing the example of a configuration of the thermoregulator for the temperature control of nitrogen gas.
[Drawing 4] It is a sectional view for explaining the configuration of an external hybrid model two fluid nozzle.
[Description of Notations]
10 Spin Chuck
15 Rotation Drive
20 Scanning Nozzle Device
21 Software Spray Nozzle
23 Swinging Arm
24 Fixed Pivot
25 Revolution Drive
40 Rise-and-Fall Drive
50 Drug Solution Tank 50
51 Drug Solution Inflow Port
52 Drug Solution Outflow Port
53 54 Cylindrical shape insertion hole
61 62 Lamp heater
65 Temperature Sensor
70 Controller
71 Metal Piping
72 Heating-Wire Heater
73 Temperature Sensor
75 Controller
81 Liquid Induction
81a Liquid supply way
82 Gas Induction
82a Gas inlet
84 Gas Path
140 Etching-Reagent Charging Line
140a Etching-reagent supply bulb
141 Rinse Charging Line
141a Rinse supply bulb
210 Liquid Induction
210a Liquid installation way
211 Gas Induction

211a Gas installation way
212 Drop Formation Discharge Part
212a Taper section
212b Straight section
220 Etching-Reagent Charging Line
220a Etching-reagent supply bulb
220b Thermoregulator
220c Filter
221 Rinse Charging Line
221a Rinse supply bulb
221b Thermoregulator
222 Nitrogen Gas Supply Piping
222 Nitrogen Charging Line
222a Nitrogen gas supply bulb
222b Thermoregulator
222b Gas thermoregulator
P1 Processing location
SP1 Space
SP2 Space
SP3 Space
SP3 Space (mixing chamber)
W Wafer

[Translation done.]

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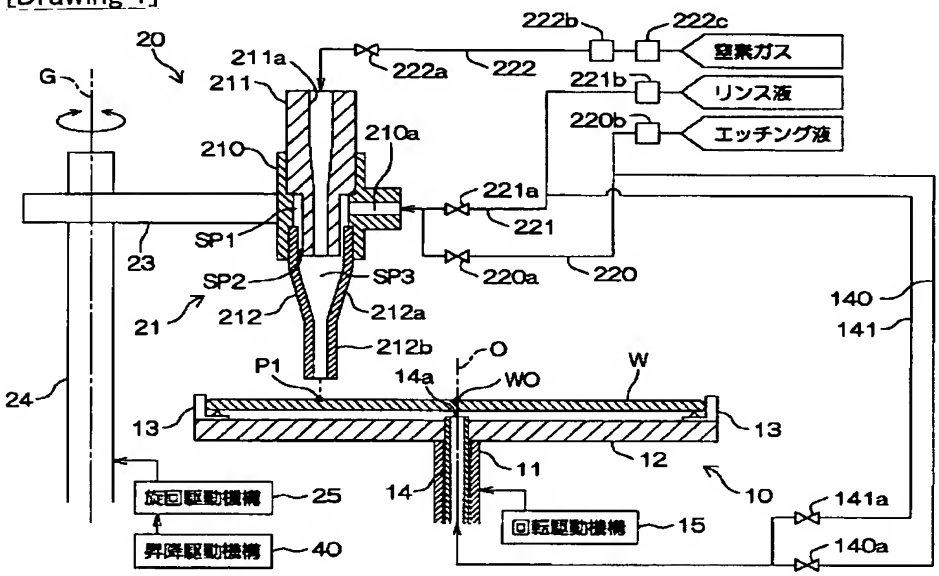
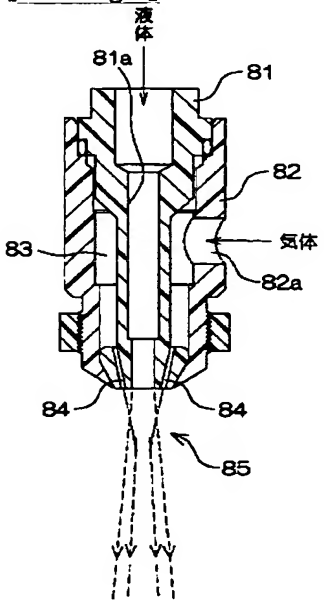
DRAWINGS

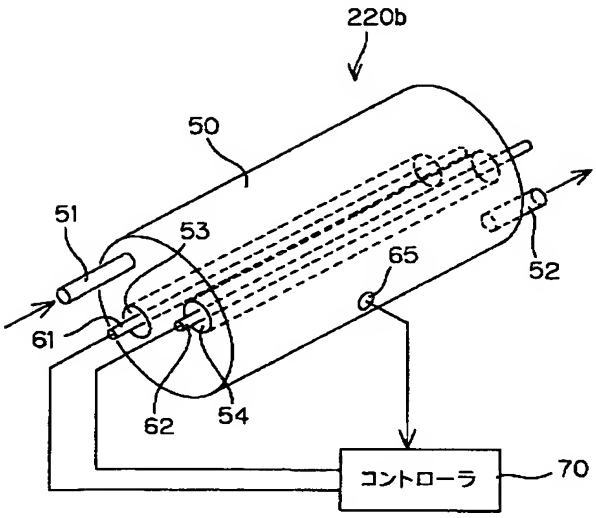
[Drawing 1]



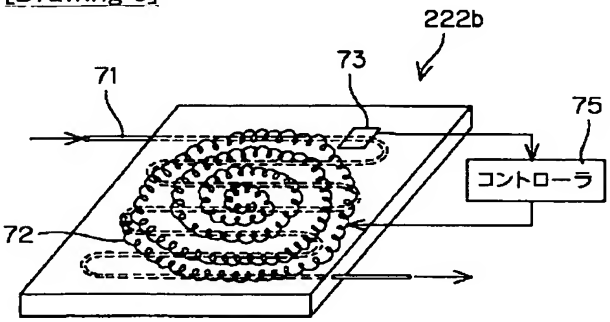
[Drawing 4]



[Drawing 2]



[Drawing 3]



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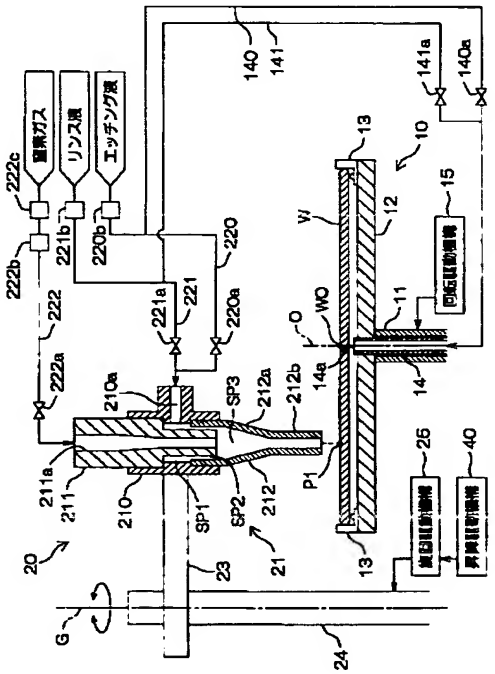
(54)【発明の名称】　基板処理装置および基板処理方法

(57)【要約】
【課題】所望の温度の液滴を基板表面に噴射することができ、これにより基板処理効率を高めることができる基板処理装置および基板処理方法を提供する。
【解決手段】この基板処理装置は、気体と液体とが混合されて生成された液滴をウエハＷの表面に噴射してウエハＷの表面を処理する。この装置は、気体と液体とを混合させて液滴を生成させ、この液滴を基板の表面にソフトスプレーノズル２１と、このソフトスプレーノズル２１にエッチング液およびリンス液をそれぞれ供給するエッチング液供給配管２２０およびリンス液供給配管２２１と、ソフトスプレーノズル２１に窒素ガスを供給する窒素ガス供給配管２２２とを備えている。エッチング液供給配管２２０、リンス液供給配管２２１および窒素ガス供給配管２２２には、それぞれ、温度調節器２２０ｂ，２２１ｂ，２２２ｂが介装されている。



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【特許請求の範囲】
【請求項１】気体と液体とが混合されて生成された液滴を基板の表面に噴射して基板表面を処理する基板処理装置であって、
気体と液体とを混合させて液滴を生成させ、この液滴を基板の表面に噴射するノズルと、
このノズルに接続され、このノズルに液体を供給する液体供給管と、
上記ノズルに接続され、このノズルに気体を供給する気体供給管と、
この気体供給管を流通する気体の温度を調節する気体温度調節手段とを含むことを特徴とする基板処理装置。
【請求項２】上記液体供給管を流通する液体の温度を調節する液体温度調節手段をさらに含むことを特徴とする請求項１記載の基板処理装置。
【請求項３】上記気体温度調節手段および上記液体温度調節手段は、上記気体供給管および液体供給管をそれぞれ流通する気体および液体を、互いに等しい温度に調節するものであることを特徴とする請求項２記載の基板処理装置。
【請求項４】上記ノズルは、上記液体供給管からの液体と上記気体供給管からの気体とを混合する混合室を内部に有する内部混合型二流体ノズルであることを特徴とする請求項１ないし４のいずれかに記載の基板処理装置。
【請求項５】気体と液体とが混合されて生成された液滴を基板の表面に噴射して基板表面を処理する基板処理方法であって、
ノズルに接続された液体供給管に液体を供給する工程と、
上記ノズルに接続された気体供給管に気体を供給する工程と、
上記気体供給管を流通する気体の温度を調節する工程と、
上記ノズルから、基板の表面に向けて、上記液体供給管から供給される液体と上記気体供給管から供給される気体とが混合されて生成された液滴を噴射する工程とを含むことを特徴とする基板処理方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、気体と液体とが混合された液滴を基板の表面に噴射して基板を処理する基板処理装置および基板処理方法に関する。処理対象の基板には、半導体ウエハ、液晶表示装置用ガラス基板、プラズマディスプレイ用ガラス基板、光ディスク用基板、磁気ディスク用基板、光磁気ディスク用基板、フォトマスク用基板などの各種の基板が含まれる。
【０００２】
【従来の技術】半導体装置の製造工程では、半導体ウエハ（以下単に、「ウエハ」という。）を洗浄するために基板洗浄装置が用いられる。この用途の基板洗浄装置と

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しては、ウエハの表面に薬液（エッチング液など）または純水を供給しながら、スクラブブラシでウエハ表面をスクラブする構成のものが、従来から使われてきた。しかし、最近では、極微細パターンが形成されたウエハ表面を精密に洗浄するために、スクラブブラシに代えて、スプレーノズルからウエハ表面に向けて液滴を噴射する、いわゆるソフトスクラバ方式のものが採用されるようになってきている。
【０００３】スプレーノズルは、二流体ノズルともよばれ、ノズル本体に液体供給管および気体供給管が結合可能になっている。液体供給管および気体供給管からノズル本体に液体および気体を所定流量で供給することにより、気体と液体との混合によって液滴の噴流が形成され、この液滴の噴流がウエハ表面に向けて噴射される。ウエハ表面からのパーティクル除去効果を高めるために、一般に、薬液の温度調節が行われる。この温度調節は、液体供給管を流通する薬液の温度を調節することによって達成される。
【０００４】
【発明が解決しようとする課題】しかし、薬液の温度を室温よりも高く調節する場合には、気体との混合によって熱が奪われるので、薬液の温度低下は免れず、ウエハ表面に到達する薬液の液滴の温度は、調節された温度よりも低くなる。したがって、必ずしも期待どおりのパーティクル除去効果が得られず、洗浄不良となるおそれがある。そこで、この発明の目的は、上述の技術的課題を解決し、所望の温度の液滴を基板表面に噴射することができ、これにより基板処理効率を高めることができる基板処理装置および基板処理方法を提供することである。
【０００５】
【課題を解決するための手段および発明の効果】上記の目的を達成するための請求項１記載の発明は、気体と液体とが混合されて生成された液滴を基板（Ｗ）の表面に噴射して基板表面を処理する基板処理装置であって、気体と液体とを混合させて液滴を生成させ、この液滴を基板の表面に噴射するノズル（２１）と、このノズルに接続され、このノズルに液体を供給する液体供給管（２２０，２２１）と、上記ノズルに接続され、このノズルに気体を供給する気体供給管（２２２）と、この気体供給管を流通する気体の温度を調節する気体温度調節手段（２２２ｂ）とを含むことを特徴とする基板処理装置である。なお、括弧内の英数字は後述の実施形態における対応構成要素等を表す。以下、この項において同じ。
【０００６】この構成によれば、気体温度調節手段によって温度調節された気体がノズルに導かれ、この気体と液体供給管からの液体との混合により、液滴が生成されて基板表面に噴射される。したがって、液体と気体との混合に起因して、液体と気体との間で不所望な熱交換が生じることを防止できる。その結果、適切な温度の液滴を基板表面に導くことができるから、基板処理効率を高

めることができる。たとえば、請求項２記載のように、液体供給管を流通する液体の温度を調節する液体温度調節手段（２２０ｂ，２２１ｂ）をさらに設けることによって、液滴の温度をさらに正確に調節できるから、基板の処理効率をさらに向上できる。

【０００７】液体供給管からの液体と気体供給管からの気体との温度に相違があれば、液体と気体との間での熱交換が生じるから、これを利用して、液滴の温度調節を行うこともできる。この場合には、液体温度調節手段は必ずしも必要ではない。気体温度調節手段および液体温度調節手段の両方を設ける場合には、請求項３に記載のように、気体温度調節手段および液体温度調節手段は、上記気体供給管および液体供給管をそれぞれ流通する気体および液体を、互いに等しい温度に調節するものであることが好ましい。これによって、厳密に温度調節された液滴を基板表面に導くことができるから、効率的な基板処理が可能である。

【０００８】上記ノズルは、請求項４に記載のように、上記液体供給管からの液体と上記気体供給管からの気体とを混合する混合室を内部に有する内部混合型二流体ノズルであってもよい。また、上記ノズルは、ノズルの外部の空中で気体と液体とを混合させて液滴を生成する外部混合型二流体ノズルであってもよい。ただし、外部混合型二流体ノズルでは、気体と液体との混合がノズルの外部で行われて、液滴が傘状に拡散するのに対して、内部混合型二流体ノズルでは、気体と液体の混合がノズルの内部で行われるうえ、直進性の良好な液滴噴流を形成できるので、内部混合型二流体ノズルの方が、液滴の温度変化が生じにくい。したがって、内部混合型二流体ノズルを使用する方が、良好な基板処理効率を達成できる。

【０００９】気体温度調節手段および液体温度調節手段は、４０℃～７０℃の範囲に気体および液体の温度をそれぞれ調節するものであってもよい。また、液体温度調節手段は、たとえば気体供給管の一部を金属管（７１）で構成し、この金属管に近接して電熱ヒータ（７２）および温度センサ（７３）を配置し、温度センサの検出温度に基づいて電熱ヒータを通電制御する構成のものであってもよい。

【００１０】一方、液体温度調節手段は、たとえば液体供給管の少なくとも一部を石英管（５０）で構成するとともに、この石英管に近接して加熱ランプ（６１，６２）および温度センサ（６５）を配置するとともに、温度センサの出力に基づいて加熱ランプの通電制御を行う構成であってもよい。一般に、液体温度調節手段は気体温度調節手段よりも構成が複雑であるので、液体温度調節手段を設けることなく、気体温度調節手段による気体の温度調節のみを行い、液体の温度調節は、専ら、気体と液体との混合時における高者間での熱交換によって行う構成を採用すれば、全体の構成が著しく簡素化される。

【００１１】請求項５記載の発明は、気体と液体とが混合されて生成された液滴を基板（Ｗ）の表面に噴射して基板表面を処理する基板処理方法であって、ノズル（２１）に接続された液体供給管（２２０，２２１）に液体を供給する工程と、上記ノズルに接続された気体供給管（２２２）に気体を供給する工程と、上記気体供給管を流通する気体の温度を調節する工程と、上記ノズルから、基板の表面に向けて、上記液体供給管から供給される液体と上記気体供給管から供給される気体とが混合されて生成された液滴を噴射する工程とを含むことを特徴とする基板処理方法である。

【００１２】この方法により、請求項１の発明に関連して述べた効果と同様な効果を達成できる。

【００１３】

【発明の実施の形態】以下では、この発明の実施の形態を、添付図面を参照して詳細に説明する。図１は、この発明の一実施形態に係る基板処理装置の構成を説明するための概念図である。この基板処理装置は、いわゆるソフトスクラバ処理によって、基板の一種であるウエハＷの表面の洗浄を行うための基板洗浄装置である。この基板処理装置は、ウエハＷをほぼ水平に保持して回転するスピンチャック１０と、スピンチャック１０に保持されたウエハＷの上面に沿ってソフトスプレーノズル２１を揺動させるスキャンノズル機構２０と、スピンチャック１０に保持されたウエハＷの裏面（下面）の中央に向けて処理液を供給するための裏面ノズル１４とを備えている。

【００１４】スピンチャック１０は、鉛直方向に沿って配置された中空の回転軸１１の上端にスピンベース１２をほぼ水平に取り付けるとともに、このスピンベース１２の回転半径方向外方端に挟持爪１３を立設して構成されている。挟持爪１３は、スピンベース１２上に複数個設けられていて、ウエハＷの周方向の異なる位置を複数箇所で保持するようになっている。回転軸１１には、回転駆動機構１５から回転駆動力が与えられる。これにより、挟持爪１３によって挟持されてほぼ水平に保持されたウエハＷが、鉛直方向に沿う回転軸線Ｏ回りに回転されることになる。

【００１５】裏面ノズル１４は、回転軸１１を挿通するように設けられた処理液供給管からなり、その上端に、ウエハＷの下面中央付近に開口した吐出口１４ａを有している。この裏面ノズル１４には、エッチング液供給源からのエッチング液（薬液）がエッチング液供給配管１４０およびエッチング液供給バルブ１４０ａを介して与えられるほか、リンス液供給源からのリンス液（純水）が、リンス液供給配管１４１およびリンス液供給バルブ１４１ａを介して与えられるようになっている。

【００１６】エッチング液供給バルブ１４０ａまたはリンス液供給バルブ１４１ａを選択的に開くことによっ

て、裏面ノズル１４からウエハWの裏面中央にエッチング液または純水を供給できる。この状態でスピンチャック１０が回転されることによって、ウエハWの裏面に供給された処理液（エッチング液またはリンス液）が遠心力によって回転半径方向外方側に導かれて、ウエハWの裏面全域に処理液が行き渡ることになる。

【００１７】スキャンノズル機構２０は、スピンチャック１０の側方において鉛直方向に沿って設けられた旋回軸２４と、この旋回軸２４の上端付近にほぼ水平に固定された揺動アーム２３と、この揺動アーム２３の先端部に固定されたソフトスプレーノズル２１とを備えている。旋回軸２４には、この旋回軸２４を鉛直方向に沿う回転軸線G回りに回転駆動する旋回駆動機構２５が結合されている。さらに、旋回駆動機構２５および旋回軸２４は、昇降駆動機構４０によって昇降されるようになっている。

【００１８】ソフトスプレーノズル２１は、いわゆる内部混合型の二流体ノズルであって、気体導入部２１１と、液体導入部２１０と、液滴形成吐出部２１２とが連結されて構成されている。気体導入部２１１、液体導入部２１０および液滴形成吐出部２１２はいずれも管形状を有していて、これらが直列に連結されてソフトスプレーノズル２１が構成されている。液滴形成吐出部２１２は、液体導入部２１０の下方端に連結されており、下方に向かうに従って内径が小さくなるテーパ部２１２ａと、この２１２ａの下端に連なり、内径が一様な直管形状のストレート部２１２ｂとを有している。

【００１９】気体導入部２１１は、液体導入部２１０の上側部に係合する大径部と、この大径部の下方に連なって液滴形成吐出部２１２の内部空間にまで達する小径部とを有し、その内部には先細り形状の気体導入路２１１ａが形成されている。液体導入部２１０には、液体を導入するための液体導入路２１０ａが側方に開口して形成されており、この液体導入路２１０ａは、気体導入部２１１の小径部と液体導入部２１０の内壁との間のリング状の空間ＳＰ１に連通している。この空間ＳＰ１は、気体導入部２１１の小径部と液滴形成吐出部２１２の内壁との間のリング状の空間ＳＰ２を介して、液滴形成吐出部２１２のテーパ部２１２ａの内部空間ＳＰ３（混合室）と連通している。

【００２０】気体導入部２１１の気体導入路２１１ａには、窒素ガス供給源からの窒素を供給する窒素供給配管２２２が接続されている。この窒素供給配管２２２の途中部には、窒素ガス供給源側から順に、フィルタ２２０ｃ、温度調節器２２２ｂおよび窒素ガス供給バルブ２２２ａが介装されている。液体導入路２１０ａには、リンス液供給配管２２１およびエッチング液供給配管２２０が接続されている。エッチング液供給配管２２０の途中部には、エッチング液供給源側から順に、温度調節器２２０ｂおよびエッチング液供給バルブ２２０ａが介装されている。また、リンス液供給配管２２１の途中部には、リンス液供給源側から順に、温度調節器２２１ｂおよびリンス液供給バルブ２２１ａが介装されている。

【００２１】ソフトスプレーノズル２１では、気体導入路２１１ａから供給される気体と、液体導入路２１０ａから空間ＳＰ１，ＳＰ２を介して供給される気体とが、空間ＳＰ３において混合され、その結果、液滴が形成されることになる。この液滴は、テーパ部２１２ａで加速され、ストレート部２１２ｂを介して、ウエハWに向けて噴射される。この液滴の噴流は、ストレート部２１２ｂの働きにより、極めて良好な直進性を有する。

【００２２】液滴の粒径は、たとえば、５μｍ～２０μｍである。また、ソフトスプレーノズル２１に供給される気体（窒素ガス）の流量は、５０リットル／分～１００リットル／分であることが好ましく、ソフトスプレーノズル２１に供給される液体（エッチング液またはリンス液）の流量は、１００ミリリットル／分～１５０ミリリットル／分であることが好ましい。ウエハWの回転速度（スピンチャック１０の回転速度）は、１０ｒｐｍ～１０００ｒｐｍが適当である。

【００２３】温度調節器２２０ｂ，２２１ｂ，２２２ｂは、いずれも、等しい温度（たとえば４０℃～７０℃）にエッチング液、リンス液および窒素ガスをそれぞれ温度調節する。したがって、空間ＳＰ３（混合室）において気体と液体とが混合されるときに、気体と液体との間での温度交換が生じない。よって、良好に温度調節されたエッチング液またはリンス液の液滴をウエハWの表面に導くことができる。これにより、ウエハWの効率的な処理が可能になる。

【００２４】ソフトスプレーノズル２１によるウエハWの処理時には、スピンチャック１０は回転駆動機構１５の働きによって回転され、エッチング液供給バルブ２２０ａまたはリンス液供給バルブ２２１ａが開かれ、さらに窒素ガス供給バルブ２２２ａが開かれる。それとともに、昇降駆動機構４０の働きにより、ストレート部２１２ｂの下端がウエハWの近傍に配置されるとともに、旋回駆動機構２５の働きによって、揺動アーム２３が揺動させられる。これによって、ソフトスプレーノズル２１からの液滴の噴流が導かれるウエハW表面の処理位置Ｐ１は、ウエハWの回転中心ＷＯからその回転半径外方端まで繰り返し移動することになる。

【００２５】このとき、必要に応じてエッチング液供給バルブ１４０ａまたはリンス液供給バルブ１４１ａが開成されて、裏面ノズル１４からウエハWの裏面中央にエッチング液またはリンス液が供給される。図２は、エッチング液の温度調節を行うための温度調節器２２０ｂの構成例を説明するための図解的な斜視図である。この温度調節器２２０ｂは、エッチング液供給配管２２０を流通する薬液（エッチング液）が流通する石英製の薬液タンク５０と、ランプヒータ６１，６２とを備えている。

薬液タンク５０は、ほぼ直円筒形状を有していて、一方端面に薬液流入ポート５１を有し、他方端面に薬液流出ポート５２を有している。さらに、薬液タンク５０には、両端面間を挿通する円筒形挿通孔５３，５４が、軸線方向に沿って形成されている。この円筒形挿通孔５３，５４に直管状のランプヒータ６１，６２がそれぞれ挿通されている。薬液タンク５０の周面には温度センサ６５が配置されていて、この温度センサ６５の出力に基づき、コントローラ７０がランプヒータ６１，６２への通電を制御するようになっている。

【００２６】この温度調節器２２０ｂをエッチング液供給配管２２０に介装することによって、エッチング液供給配管２２０を流通するエッチング液の温度を調節することができる。リンス液供給配管２２１に介装された温度調節器２２１ｂも、エッチング液用の温度調節器２２０ｂと実質的に同様な構成となっている。図３は、窒素ガス供給配管２２２に介装された温度調節器２２２ｂの構成例を示す図解的な斜視図である。この温度調節器２２２ｂは、ジグザグに配置された金属配管７１と、この金属配管７１上にたとえば渦巻状に配置された電熱線ヒータ７２とを備えている。金属配管７１に接触して（または金属配管７１からの熱が伝達される伝熱部材に接触して）温度センサ７３が設けられており、この温度センサ７３の出力に基づき、コントローラ７５が電熱線ヒータ７２への通電を制御する。この構成により、金属配管７１を流通する気体を所望の温度に調節することができる。

【００２７】以上のように、この実施形態によれば、ソフトスプレーノズル２１に供給されるエッチング液およびリンス液の温度調節が行われるとともに、これらの液体と混合される窒素ガスの温度も調節されるようになっている。そして、等しい温度に調節された窒素ガスとリンス液またはエッチング液とがソフトスプレーノズル２１で混合され、エッチング液またはリンス液の液滴がウエハＷの表面に向けて噴射される。等しい温度の窒素ガスとリンス液またはエッチング液との間では熱交換が生じないので、確実に所望の温度のエッチング液またはリンス液の液滴をウエハＷの表面に導くことができ、これにより、ウエハＷの表面を効率的に処理することができる。

【００２８】この発明の一実施形態の説明は、以上のとおりであるが、この発明は他の形態で実施することもできる。たとえば、上記の実施形態では、内部混合型の二流体ノズルをソフトスプレーノズル２１として用いた基板処理装置について説明したが、外部混合型の二流体ノズルをソフトスプレーノズル２１として用いてもよい。外部混合型二流体ノズルは、図４に示すように、液体導入部８１と、この液体導入部８１よりも大径の気体導入部８２とを同軸に嵌合して構成されている。

【００２９】液体導入部８１は、気体導入部８２をほぼ貫通していて、その内部に形成された液体供給路８１ａは、ノズル先端近傍の外部空間に連通している。一方、気体導入部８２は、側面に気体導入口８２ａを有していて、この気体導入口８２ａは、気体導入部８２の内部において、その内壁と液体導入部８１の外壁との間に形成された空間８３に連通している。液体導入部８１の先端部は、外方に広がった鍔形状に形成されていて、この鍔形状部には、上記の空間８３と当該ソフトスプレーノズルの先端近傍の外部空間との間を連通させる気体通路８４が形成されている。

【００３０】この構成によって、液体供給路８１ａに液体を供給するとともに、気体導入口８２ａから気体を供給すると、ノズル先端付近の外部空間８５において、液体と気体とが空中で混合され、液滴が形成されることになる。この液滴は、液体および気体の吹き出し方向、すなわち液体導入部８１の軸方向に沿って噴射される。ただし、この外部混合型二流体ノズルでは、内部混合型二流体ノズルに比較して、液滴の直進性があまり良くなく、液滴の噴流は、傘状に広がる。

【００３１】内部混合型二流体ノズルと外部混合型二流体ノズルとを比較すると、内部混合型二流体ノズルでは、気体と液体との混合がノズル内部で行われるとともに、液滴噴流の直進性が良いので、液滴の温度変化が生じにくく、ウエハＷの表面に確実に所望の温度の液滴を供給することができる点で有利である。したがって、内部混合型二流体ノズルをソフトスプレーノズル２１として用いることにより、より効率の高い基板処理が可能である。

【００３２】また、上記の実施形態では、窒素ガスの温度を温度調節器２２２ｂで調節するとともに、エッチング液およびリンス液の温度を温度調節器２２０ｂ，２２１ｂで調節することとしているが、エッチング液およびリンス液のための温度調節器２２０ｂ，２２１ｂを省いて、構成をさらに簡素化することもできる。この場合、温度調節器２２２ｂによって、窒素ガスの温度を所望の液滴温度よりも高く設定しておくことが好ましい。これにより、ソフトスプレーノズル２１における窒素ガスおよびエッチング液またはリンス液の混合により、窒素ガスとエッチング液またはリンス液との間で熱交換が生じて、所望の温度の液滴をウエハＷの表面に向けて噴射することができる。窒素ガスのための温度調節器２２２ｂの構成は、エッチング液またはリンス液のための温度調節器２２０ｂ，２２１ｂの構成に比較して格段に簡易であるので、構成が著しく簡単になるとともに、基板処理装置のコストダウンに寄与することができる。

【００３３】その他、特許請求の範囲に記載された事項の範囲で種々の設計変更を施すことが可能である。

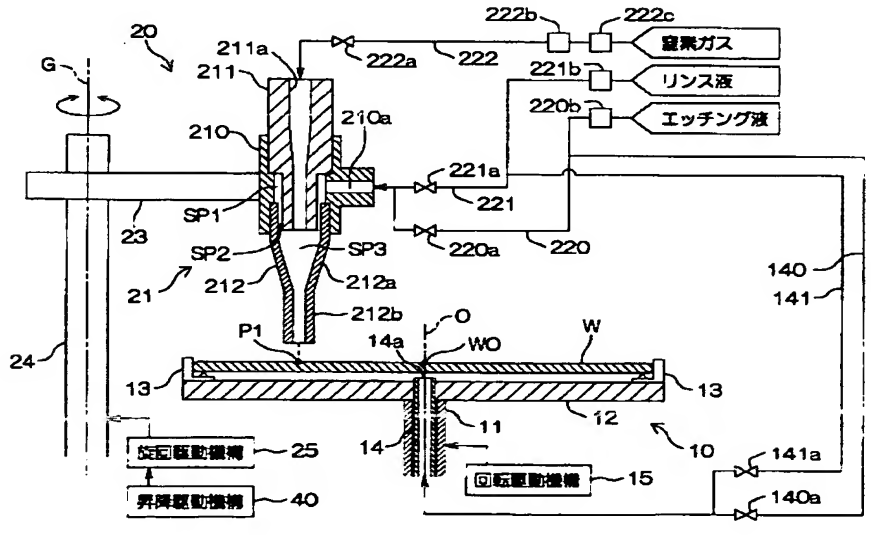
【図面の簡単な説明】

【図１】この発明の一実施形態に係る基板処理装置の構成を説明するための概念図である。

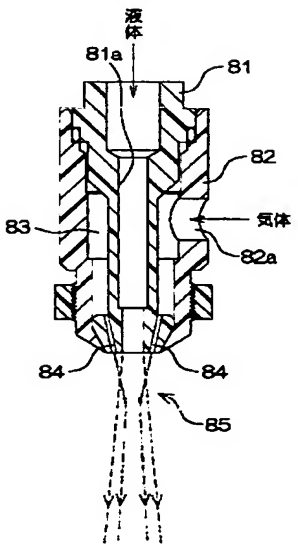
【図２】エッチング液の温度調節を行うための温度調節器の構成例を説明するための図解的な斜視図である。
【図３】窒素ガスの温度調節のための温度調節器の構成例を示す図解的な斜視図である。
【図４】外部混合型二流体ノズルの構成を説明するための断面図である。
【符号の説明】

１０	スピンチャック	＊８４	気体通路
１５	回転駆動機構	１４０	エッチング液供給配管
２０	スキャンノズル機構	１４０ａ	エッチング液供給バルブ
２１	ソフトスプレーノズル	１４１	リンス液供給配管
２３	揺動アーム	１４１ａ	リンス液供給バルブ
２４	旋回軸	２１０	液体導入部
２５	旋回駆動機構	２１０ａ	液体導入路
４０	昇降駆動機構	２１１	気体導入部
５０	薬液タンク５０	２１１ａ	気体導入路
５１	薬液流入ポート	２１２	液滴形成吐出部
５２	薬液流出ポート	２１２ａ	テーパ部
５３，５４	円筒形挿通孔	２１２ｂ	ストレート部
６１，６２	ランプヒータ	２２０	エッチング液供給配管
６５	温度センサ	２２０ａ	エッチング液供給バルブ
７０	コントローラ	２２０ｂ	温度調節器
７１	金属配管	２２０ｃ	フィルタ
７２	電熱線ヒータ	２２１	リンス液供給配管
７３	温度センサ	２２１ａ	リンス液供給バルブ
７５	コントローラ	２２１ｂ	温度調節器
８１	液体導入部	２２２	窒素ガス供給配管
８１ａ	液体供給路	２２２	窒素供給配管
８２	気体導入部	２２２ａ	窒素ガス供給バルブ
８２ａ	気体導入口	２２２ｂ	温度調節器
		２２２ｂ	気体温度調節器
		Ｐ１	処理位置
		ＳＰ１	空間
		ＳＰ２	空間
		ＳＰ３	空間
		ＳＰ３	空間（混合室）
		＊30 Ｗ	ウエハ

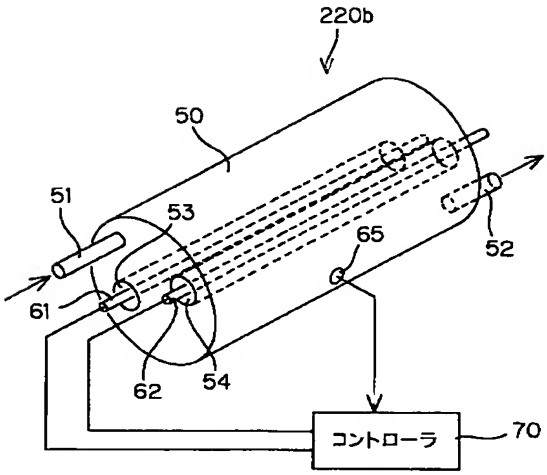
【図１】



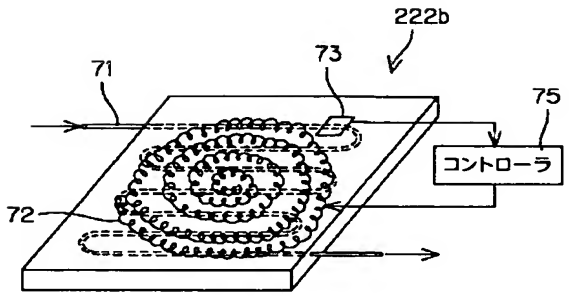
【図４】



【図２】



【図３】



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